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RANGE IMPROVEMENT

TECHNICAL NOTES NO. I

Guideline to Experiments

Alberta
Dept of ENERGY AND
NATURAL RESOURCES

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Technical Note and Its Purpose

This publication is printed primarily to inform land use managers and technicians of Alberta Forest Service of developments in the field of range management and research carried out in the different Forests. This is published serially as and when technical notes are received from the field personnel. It normally includes final reports on experiments that are concluded, but preliminary reports on on-going experiments are also included. It enables one to be aware of what is happening in range management and research in other Forests.

Distribution of this among the Forestry personnel should generate interest and discussion on the various topics dealt with in those experiments. Discussion and constructive criticism should lead to better planning of experiments, recording of observations, and writing up of these technical notes. Above all the main purpose of these technical notes is that those who read these will adopt and apply the results and conclusive findings reported in these technical notes to their areas and take advantage of work done by others.

All who read these notes are encouraged to submit materials for publication, and these can be useful personal observations, reports on experiments conducted by other agencies, or suggestions for improving the usefulness of this publication.

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Guidelines for Conducting Trials and
Experiments in Forest Areas of Alberta

By

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Department of Lands and Forests

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GUIDELINES FOR CONDUCTING TRIALS AND EXPERIMENTS IN FOREST AREAS OF ALBERTA

Introduction

For a long time, forest research and experimentation seemed to be the exclusive domain of the Government of Canada, Departments of Forestry and Agriculture. Due to various reasons, immediate and localized problems in resource management which are of special concern to Alberta Forest Service were not or could not be undertaken by Canadian Forest Service. With the new awareness of our renewable and non-renewable resources, their management and the attendant problems connected with their utilization, Alberta Forest Service is faced with finding out answers to many questions at short notice.

Although experiments and trials have been conducted in the past to solve local problems, the need for a broad approach to applied land use research has come to the forefront only recently. With this in mind, the Land Use Research Section of the Forest Land Use Branch is endeavouring to suggest standard experiments and to coordinate, as much as possible, studies conducted in different Forests. At the present time, we are engaged in experiments concerning range management, watershed management, erosion control and mined land rehabilitation. Problems of water pollution, soil pollution (oil spills), and air pollution are also in the picture.

In order to have a uniform policy and to have some basic ground rules for experimental designs, a simple set of guidelines is set forth for the use of all Forest personnel. The results of a well planned experiment are more valuable than those from a trial laid out in a haphazard manner. It is suggested that simple experiments be designed, limited to the extent that they may receive ample attention, and that a permanent record of all observations be maintained.

We hope that these guidelines will pave the way to better understanding of laying out of experiments. These guidelines can be modified to suit particular needs and circumstances. Any comments will be welcome.

We would also appreciate receiving copies of detailed plans of future experiments, and will be pleased to offer advice and assistance in implementing studies in the field.

Objectives

Trials and experiments can come under different categories, like range improvement, erosion control and mined land reclamation. The first thing to be done is to provide funds for the project. The next step is to write down the objectives of the project, i.e., what are the results expected or desired of the experiment. Some of the objectives are: which grass and legume are best suited for the area - trials with shrubs and trees are not uncommon; which type of seedbed preparation (clearing, clearing and breaking, harrowing, ploughing, rototilling) is good for that area and for the particular plant species; whether fertilizer has any effect on the plant growth; which dose of fertilizer is effective and economical; which planting season (early spring or late fall) is better. If we are dealing with acid or alkaline soils, our objective can be to find which kind of alkalizing or acidifying fertilizer is effective and economical. In mined land reclamation work, soil stabilization can be very important and in such case the objectives are to find out the best slope and at what intervals we should have terraces and what width the terraces should be. Then choose the plant species, seedbed preparation methods, fertilizer rates and time of sowing. At this point of time the whole experiment should be plotted on paper.

Replication

It is always better to keep the experiment as simple as possible and to try in one location first. However, it may be necessary to conduct the same experiment on different locations (different elevations, different soil types, on slopes and level ground) at the same time. It is also preferable to have the experiment repeated (replication of plots or treatments) at the same location. Generally the results obtained from replicated experiments are more valid than those obtained from unreplicated experiments. To a certain degree, large plots can be considered more or less equal to having replications with small sized plots.

As replications are carried out in the same area, the results of replicated experiments reflect the average reaction between the treatments and the locaility in a much better way than those of unreplicated experiments. Simply, it means that replicated experiments give a better representation of the average. For example, if we want to calculate the average income of a family in a community of 200 families, we can add up the income of 10 families taken at random out of the 200 and divide it by 10. As we have taken only 5% of the number of familes involved, the average taken from 10 families may or may not truly represent the average income of the community. However, if we take the average income of 50 families selected at random, this average will more truly reflect the average income of the community. Replications act in a similar way, that of taking more samples from the community (or whole area).

Plan

A definite plan should be drawn out on paper. It is advisable to leave sufficient space as foot-paths between plots to facilitate easy observation of plots. When the length and breadth of the experimental area are known, a detailed plan of the experiment should be drawn to a sutiable scale. The plant material and other treatments going into each plot should be noted on the plan. Allocating plant species to particular plots can be done in a randomized fashion. Please see the footnote below the plan in the example (Page 11).

Location

The location of the experiment should be representative of the large area for which the results are intended or will apply. It should be of sufficient size and preferably uniform. Experimental area should be fairly near to the Ranger Station and be easily accessible, to facilitate frequent visits to the location for making observation and taking notes. It should be marked on a map showing all the roads and trails leading to the experimental suite. Anybody should be able to go to the location with the help of that map, directly without any difficulty and in the absence of the concerned Ranger, who alone in most cases is familiar with the route. The

actual experimental area should be marked out with knee-high stub posts. Ordinary fence posts are not recommended because cattle may use them as rubbing posts and may eventually knock them down. Experimental plots can be marked by 2" slats and can easily be located by measuring the distance between them and the corner stub posts. It is also a good idea to mark the location by tying it with a well known bench mark. When all these are written down, anyone can locate the spot easily and take observations without any loss of time.

Record of Observations

Observations are to be recorded before the start of the experiment, periodically during the course of the experiment and at the end of the experiment. Observations are to be recorded on a permanent basis in bound notebooks or loose leaf binders. These should be kept up for a few years or until the experiment is concluded or abandoned. Some of the type of observations that are to be recorded are given below.

Site: Elevation, aspect, slope, and latitude.

Soil: Type of profile, colour, texture, depth, stoniness, pH value, and complete soil analysis wherever possible. Type of erosion, siltation in the stream, bare ground, and litter accumulation, especially for erosion control work.

Vegetation: Trees, browse (shrubs), forbs, grasses, grasslike plants and poisonous plants, their growth habit (vigour), and present utilization by domestic stock and big game. Germination, rooting of cuttings, rate of growth, tillering, rhizomatous spread, palatability, density of stand, seed setting, survival after a few years, depth and spread of roots.

It is advisable to keep photographic records of all experiments. It is not necessary to waste a lot of money on films. However, it is essential to have a few phases of the experiment on photographic record - original state of the site, after the site is prepared, during the growth

of plants and the final result. Photographs should be taken from the same particular point and at the same angle. If year after year record is kept, it is preferable to take pictures on the same dates and at the same time. Seasons, and morning and evening times make quite a difference in the pictures. For proper comparison it is necessary to keep all conditions (time, day, month, photopoint and angle) the same as far as possible. When the heights of plants are compared, it is better to have a yard stick or even a shovel next to the plants to give an idea about the actual height. Photographs should tell a story by themselves. Photographs of special equipment and machinery would be useful.

The following paragraphs under the different main headings give some additional points to take into consideration while planning various experiments.

Site Selection

Before making preparations for conducting any experiment, you should be clear in your own mind that an experiment is necessary. It may be possible to find a similar experiment going on in a rancher's land close to the proposed area. In such a case, if we can collect all the necessary data from that rancher, we need not go to the extent of conducting another experiment of the same sort in the same area. So, it is advisable to make an enquiry in the neighbourhood whether similar experiments as the proposed one were carried out by any individual or other agencies.

Where to conduct the trial or experiment? As mentioned before, the experimental site should be close to the Ranger station (as far as possible) and be of easy access, to make it easy for the Ranger to visit the place as often as possible to record observations. The site should be selected from such an area that it fairly well represents the whole area. Areas can differ in soil quality, elevation, precipitation and aspect.

For example, differences due to aspect can be that south facing slopes are warmer and drier than north facing slopes. In order to get results which

can be applied to different areas of varying characteristics, it is necessary to repeat the same experiment in different areas. The selection of experimental sites is very important because of the differences between various areas and of the cost involved in laying out experiments on a number of sites.

Plot Size

It is very difficult to give a hard and fast rule regarding the size of plots. Size of plot depends on various factors - quantity of seed available, time and money. Common sense and a little knowledge of sampling technique would help to decide the size of plot. If we have only a few seeds, a single row is more than sufficient, but if we are to do some watershed study, several hundred acres may be needed.

If we have sufficient area with varying soil characteristics we may have to have the experiment replicated, and in such a case, the size of plot can be small. On the other hand, if the area is fairly uniform, plot size can be bigger and replications can be kept to the minimum.

Another important point that should be kept in mind is that the plot size should be such that we can operate our equipments easily in the plots individually. So the width of the equipment will have a bearing on the size of plots.

Plant Selection

Select plants which are likely to come up in that area. These plants can be closely related to the native plants which are found in that locality. In many instances, it is not possible to get seeds of the native plants from seedsmen. For example, if a species of Agropyron is found in the area, the seeds of which are not available from commercial sources, the best thing is to try various available species of Agropyron in that area.

Further, there are different varieties of the same species, with very different characteristics. Some varieties are well known for their winter hardiness and those varieties should be selected for experimentation, as they are good for our northern climate and high elevations. Some varieties are drought resistant and they should be included in experiments where the site has poor moisture holding capacity or has long dry spells during the growing season.

It is wise to purchase and use good quality and pure seeds with high germination capacity. Most of the seeds lose their viability or germination capacity on storage. So, when ordering seeds, ask for certified seeds and ask for information on the date of harvest and the present germination capacity. If this information is not provided, a simple germination test can be conducted before sowing the seeds. One hundred seeds can be neatly arranged on a blotting paper laid in a flat tray and kept moist continuously for a week or so. The tray can be kept near a window for light and warmth. At the end of the week or a little longer period, the number of sprouted seeds can be counted to give the germination capacity.

In some of our erosion control work and mined land rehabilitation work, it is necessary to use shrubs and trees. The main objective in such cases is to revegetate the eroded or mined land, and therefore, the finally reclaimed area may not be or even need not be suitable as range land for domestic stock. In most cases, they can be well suited for big game. Local shrubs and trees growing in that area should be the first choice in any such trials. Shrubs like wolf willow or silverberry - *Elaeagnus commutata* and wild red raspberry - *Rubus melanolasius*, have very good spreading quality. Some of the trees and shrubs are easily propagated by stem cuttings.

Seedbed Preparation

For range improvement purposes, different methods of seedbed preparation can be tried using different equipments. Gyromower does not disturb the soil, but a rototiller can dig up the soil from 6" to 10" deep. For erosion control work, seedbed preparation need not be very elaborate. In cases of

mined land reclamation work, slope stabilization and terracing can be more important than cultivation practices.

Seeding Method

Hand seeding, cyclone seeding, hydroseeding, and drilling are some of the different methods that can be tried. While seeding, different kinds (woodpulp, straw, peat moss) of mulches can be tried. Mulches should not be thick, otherwise the young seedlings will find it difficult to penetrate the thick mass. In any case, covering the seed is very necessary. Leaving the seed on the surface of the soil will cause the seeds to be picked by birds, rodents, and ants, and also to dry up in the sun without germination or be washed downslope.

If new kinds of legumes are to be tried, or even if common legumes are to be tried in areas where they were never grown before, it is very necessary to sow the seeds mixed with the specific bacterial culture. The seedsmen should be able to supply the necessary culture along with the seed. Legumes produce nodules on their roots and these are caused by specific bacteria which fix atmospheric nitrogen in the nodule for the benefit of the plant. As most of the common legumes (alfalfa, sweet clover and clover) have been grown here for several years, those soils on which these are grown contain the bacteria pertaining to these plants. Therefore, if we are to introduce new legumes or try some of the common legumes in areas where the soil does not contain the particular bacteria, it is advisable to use the bacterial culture along with the seed.

Most of the legume seeds have hard seedcoat and in such cases, the seeds have to be scarified or abraded before sowing.

Fertilizer Application

Fertilizers can be applied separately or be drilled mixed with the seed. If drilled with seed, not more than 15 lb. of N/acre should be used. Whenever fertilizers are used, it is very essential to indicate the number of

pounds of nitrogen, pounds of phosphorus, pounds of potassium, and pounds of sulphur applied per acre. It is not enough to say that so many bags of fertilizer 16-0-0 or 16-20-0 were used. Trade names of fertilizers may be mentioned. The three numbers found on the bags denote the percentage of nitrogen, phosphorus, and potassium (in this order) contained in the fertilizer. If it contains sulphur, it is mentioned separately.

If fertilizer is to be tried on slopes on half of the experimental plots, it can be applied to any one half of the experiment, if it is divided into two halves vertically (side by side). If the experiment is divided into two halves along the contour horizontally (up and down), it is better to apply the fertilizer to the lower half. If fertilizer is applied to the upper half, the fertilizer is very likely to leach into the lower half and adversely affect the results.

Most of the grey wooded soils need some sulphur and it is better to add a little sulphur to our experimental plots. Grasses and legumes react differently to nitrogenous fertilizers. Nitrogen produces very good vegetative growth in grasses, but in the legumes it acts as a deterrent and in large doses it may kill the legumes. So, when using mixtures of seed (grass and legume) this should be kept in mind.

Generally, nitrogen is good for vegetative growth, and phosphorous is good for seed production. Normally, we need a good vigorous plant in the first year and in the subsequent years profuse seed production. According to the specific requirements, you can plan on a phased fertilizer program.

Equipment Selection

Even though for experimental purposes cost is not stressed so much, we must bear in mind that in the long run and for practical application of the results, cost should be considered as an important factor. Also, equipment available locally should be preferred to those which are to be imported from outside.

Herewith is an example of an experiment which can be modified to suite particular conditions:

Example of a Range Improvement Project

Plants to be tried - 1. Pubescent wheat grass
2. Slender wheat grass
3. Creeping red fescue
4. Timothy
5. Needle grass
6. Rambler alfalfa
7. Alsike clover
8. Yellow sweet clover
9. No seed

Seedbed Preparation - 1. No clearing
2. Clearing with a gyromower or a similar equipment
3. Clearing and breaking or use of rototiller

Fertilizer - 1. No fertilizer
2. Nitrogenous fertilizer at the rate of 60 lb. of nitrogen per acre

Plan of the Experiment

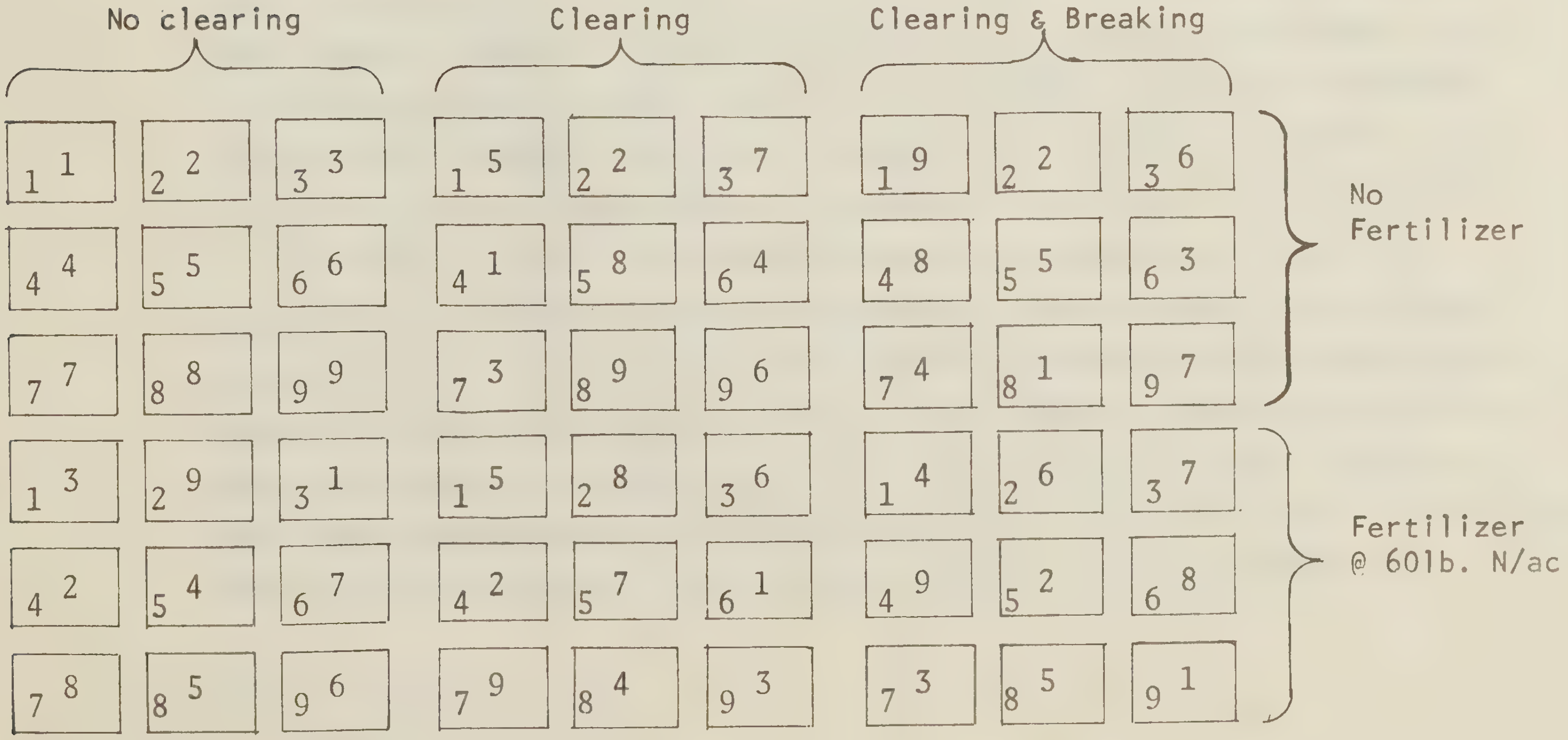
= Foot path

1-9 Plot Numbers in left front corners

Number of plots needed = 9 x 3 x 2 = 54

(Choose a suitable size for the plot)

Numbers 1-9 in the Centre of Plots denote the treatment (species) tried.



No clearing			Clearing			Clearing & Breaking			
1 1	2 2	3 3	1 5	2 2	3 7	1 9	2 2	3 6	No Fertilizer
4 4	5 5	6 6	4 1	5 8	6 4	4 8	5 5	6 3	
7 7	8 8	9 9	7 3	8 9	9 6	7 4	8 1	9 7	
1 3	2 9	3 1	1 5	2 8	3 6	1 4	2 6	3 7	Fertilizer @ 60lb. N/ac
4 2	5 4	6 7	4 2	5 7	6 1	4 9	5 2	6 8	
7 8	8 5	9 6	7 9	8 4	9 3	7 3	8 5	9 1	

Random Selection of Plots for each species

Each plant species is given a number 1-9 Write the numbers 1-9 on nine different pieces of paper and put them in a hat. Then pick one paper (number) from the hat and place that number in plot number 1. Put the paper back into the hat and pick another paper (number) and place that number in plot number 2 - and so on. Disregard if the same number is picked up a second time.

Treatments (Plant Species)

No. 1-9 (in center of plots)

1. Pubescent wheat grass
2. Slender wheat grass
3. Creeping red fescue
4. Timothy
5. Needle grass
6. Rambler alfalfa
7. Alsike clover
8. Yellow sweet clover
9. No seed

In this experiment there are 54 plots and there is no replication (experiment is not repeated). If three or four replications are desired, then this many times more plots will be required (54 x 3 or 4). Replications have more effective or representative results and have to be conducted in an area having the same characteristics. However, it may be necessary to conduct experiments on different sites or locations (low elevation grassland types; alpine or sub-alpine meadows; steep slopes; mined areas) with the same grass species. Such cases would not be considered as replications, but as different experiments.

Some discussion on the example would be helpful. When you look at the plan (sketch) you will notice that there are 54 plots or treatments, and no two plots have the same treatment. We can take all the 54 treatments together and randomly allote the treatments to the plots. In such a case we use 54 pieces of paper with the numbers or treatments written on them and put them in a hat and randomly select the treatments for the plots (please see above (page 11) for randomizing). When you plot the treatments on the plots 1 to 54, you will note that the treatments are jumbled up in such a way that fertilizing and cultivation (seedbed preparation) methods have to be applied to individual plots rather than to blocks. This is a very cumbersome process. In the example, one block of 27 plots is fertilized and this is much easier than to apply fertilizer to individual plots

scattered all over the place. So also, cultivation treatments are applied to blocks of 18 plots. That is why randomization was applied only to the plant species in the example, keeping three blocks for cultivation methods and two blocks for fertilizer treatment.

In the example, we have three types of seedbed preparations. However, due to previous knowledge and experience if we know definitely that a good seedbed is necessary and it can only be obtained by clearing and breaking, then we can very conveniently drop the two treatments - "no clearing" and "clearing." If this is done, we can either use only one block which is given the "clearing and breaking" treatment consisting of 18 plots, with no replication, or use all the three blocks (54 plots) giving them the same treatment and have three replications. Having three replications of the experiment is definitely better than having no replications at all.

Again, in the example, we have two fertilizer treatments - "no fertilizer" and "fertilizer at 60 lb N/ac." If the soil in the experimental area was analysed and the results and recommendations from the Soil and Feed Testing Lab. were available, the recommended quantity of fertilizer can be applied throughout the entire experimental area. By doing this, the two fertilizer treatments can be eliminated. If we keep the experiment as in the example, but eliminating the fertilizer treatments alone, then we will have 27 treatments and will need only 27 plots. If however, we use all the 54 plots, we will have two replications.

Further, if we eliminate "no clearing" and "clearing" and fertilizer treatments, the experimental area will be uniformly "cleared and broken" and fertilized as recommended in the soil analysis report. In such a case, we will have 9 treatments only. If we keep all the 54 plots we will have six replications of nine treatments.

It is always preferable to keep the experiments as simple and straight forward as possible. It is desirable to have some replications of treatments. Finally, periodical recording of observations at regular intervals and keeping a permenent record of observations and photographs are essential to get valuable results from any experiment.

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